BRINGING BACK THE MONARCH OF HAWAIIAN FORESTS--*ACACIA KOA*

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Koa has been called the "Monarch of Hawaiian Forests." This is a fitting title for a species found on about 500,000 acres in the State. Trees may reach 120 feet tall, 10 feet in diameter, and more than 100 feet in crown spread. Koa is important as a component of the native forest to birds, insects, mollusks, and different plant species with which it grows in association. Its wood is valued highly for furniture, cabinets, veneer, and craft pieces. The technical properties of koa wood are very similar to those of black walnut (*Juglans nigra*). The koa industry, including harvesting, manufacturing, and sale of finished products, both here and elsewhere, generates about $7,000,000 annually.

Koa forests are not as extensive as they once were. The principal reason is the effect of grazing animals that eat or otherwise damage young trees. Fire, insects, and diseases have destroyed many stands. Harvesting does not necessarily reduce the area of koa forest if natural regeneration that develops after site disturbance is allowed to grow and develop into a new forest. Too often, however, harvesting has been the first step in converting forest to pasture. An estimated 100,000 acres of koa forest have been converted to pasture in the past 50 years. Cattle, of course, are very effective in preventing reestablishment of a koa forest.

In an effort to rehabilitate denuded watersheds, many seedlings of many different species were planted on the Forest Reserves from 1900 to 1940. About 1.1 million koa seedlings were planted, making it the fourth most widely planted species. When the once barren watersheds were revegetated and when labor became scarce because of World War II, interest in reforestation with koa or other species largely ceased. Little reforestation of any kind was done during the 1940's and the early 1950's.

In the late 1950's, people began to realize the multiple values of the trees that had been planted in previous decades. Interest in reforestation was renewed, but not with koa. The Hawaii Division of Forestry built a bare-root nursery in 1961 --principally for growing pine and eucalyptus seedlings. The bare-root system of production, transport, and planting requires a hardy species if it is to work satisfactorily. And koa is definitely not a hardy species. Although interest in forestation with koa has increased during the last 10 years, efforts to use

the bare-root system have failed. Koa seedlings had been successfully raised in and planted from flats and tin cans, but because of the high cost of labor, this method was not economically feasible.

About 5 years ago, in cooperation with the Division of Forestry, I began developing a new system for successfully raising, transporting, and planting seedlings. The system is based on a small, specially designed container called the "Hawaii Dibbling Tube." The container is 5 inches deep and 1-1/8 inches inside top diameter. Four ridges that extend from top to bottom on the inside of the tube prevent root spiraling. The tubes are filled with rooting medium, then seeds are sown and covered. After about 4 months, seedlings are ready for outplanting. Seedlings are removed from the tubes, packed in wax-lined boxes, and shipped to the planting site. Seedlings are planted using a dibble which, when driven into the ground makes a hole the same size and shape as the seedling root system. The tree planter makes the hole and drops in the seedling. The dibbling tube system is proving to be efficient in terms of seedling production, transport, and planting. Its real worth is best measured by the degree of seedling survival after planting. And the bottom line, of course, is that the trees generally survive after planting.

The first planting of dibbling tube seedlings was made about 4 years ago. About 100 koa seedlings were planted in the hapu'u harvest area in the Kilauea Forest Reserve. The seedlings, grown by the green-thumb method, were of reasonable quality. We did not know then, nor do we know now, what constitutes the best seedlings in terms of stem height and diameter, leaf number and area, shoot/root ratio, etc., for maximum survival and growth on a variety of sites under a variety of weather conditions. Nor do we know the cultural treatments, such as fertilizer formulation and concentration, light intensity, temperature, etc., to obtain the best seedlings. Even with these unknowns, this first planting of koa was successful. About 95% survived, and they showed rapid initial growth. About a year later we made another planting with similar results.

Results of these two plantings indicated that koa could be successfully planted in terms of survival, growth, and costs. Reforestation with koa again became feasible.

These first efforts with koa and other species were on a research basis. In other words, we grew a few seedlings of different species and planted them on different sites to test an idea. The idea worked so we expanded from a research basis to a pilot-scale production basis--expanding from a scale of hundreds to a scale of thousands of seedlings. The pilot-scale production nursery was constructed at the Division of Forestry bare-root nursery at Kamuela.

The first crop of 40,000 koa seedlings from the pilot-scale production nursery was contracted for by the Bernice Pauahi Bishop Estate. In growing these trees, we tried to do everything to develop seedlings which would have high survival and growth

potential. For example, we collected nitrogen-fixing nodules from roots of koa seedlings growing in the area where the nursery-grown seedlings were to be planted and isolated the bacterium responsible for nitrogen fixation. The bacterium was applied to all the koa seedlings in the nursery. Seedlings were watered, fertilized, exposed to full sunlight, etc., according to the green-thumb instincts of the nurseryman. When we thought the seedlings were ready for field planting, we packed them in wax-lined boxes and shipped them to the Keauhou-Kilauea Forestry Center for planting.

The Keauhou-Kilauea Forestry Center is a project sponsored by the Bishop Estate. This project, on about 200 acres of cut-over and grazed-over koa-'ohi'a forest, is aimed at restoring koa for eventual sustained-yield management. Technical guidance for the project is being provided by State, private, and Federal organizations.

The 200-acre area was fenced and divided into four 50-acre sections. It was decided to harvest merchantable koa trees, prepare the site, and plant where necessary on 50 acres at a time. That way, if mistakes were made or better methods were developed, other areas would benefit. The area was fenced, of course, to keep out cattle.

Although natural koa reproduction generally develops in adequate numbers following site disturbance, their spatial distribution is often irregular. Seedlings are most common where seed trees once were. Koa seedlings are planted to obtain uniform stocking within an area.

A total of 36,000 seedlings were planted among the natural seedlings to obtain a 5- by 5-foot spacing between all seedlings. The first 18,000-seedling planting was done in August 1977 by Kamehameha School students and several adults. The second planting was done by welfare recipients in November.

We did learn from the first planting as evidenced by the fact that only 56% survived compared to about 98% for the second planting. Seedlings for the second planting were much hardier than those used for the first planting. Also, we were luckier the second time as rainfall was more than adequate. As of May 1978, there were about 2600 natural and planted seedlings per acre. Natural seedlings averaged about 20 inches tall. Seedlings planted in August averaged about 24 inches tall; those planted in November averaged about 16 inches tall.

We had some mortality in both natural and planted seedlings due to frost. Apparently, the opening made in the forest by harvesting and site preparation resulted in greater damage from cold air during periods of freezing temperatures in December and January. Less than 5% of the seedlings were affected.

Results of the efforts on the first 50-acre section were successful enough that work was started on the second 50 acres early in 1978. Seedlings were planted in May 1978. If we get sufficient rain, I feel certain that the survival rates will again be high. Also, because the seedlings were fertilized with 1 ounce of 10-30-10 placed in a hole next to the seedling, initial seedling growth should be rapid. This fertilizer treatment was based on a study we did which indicated that initial growth rate could be more than doubled with just 1 ounce of 10-30-10.

On the basis of results of the first crop from the pilot-scale container nursery, the Division of Forestry plans to develop it into a full production nursery with a capacity of 1 million seedlings per year.

The planting of 36,000 seedlings at Keauhou-Kilauea was the first major koa reforestation project in about 35 years. Now we have just had the second. It is exciting to think that koa reforestation is now biologically and economically feasible. We not only have the potential to bring back the monarch of Hawaiian forests, we have the ability. Now we have to do it.